

2005 Air Innovations Conference

August 24 – 26

Chicago Illinois

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“Space Conditioning: The Next Frontier,”
EPA 430-R-93-004, April 1993

“GeoExchange systems are the most energy-efficient, environmentally clean, and cost –effective space conditioning systems available.”

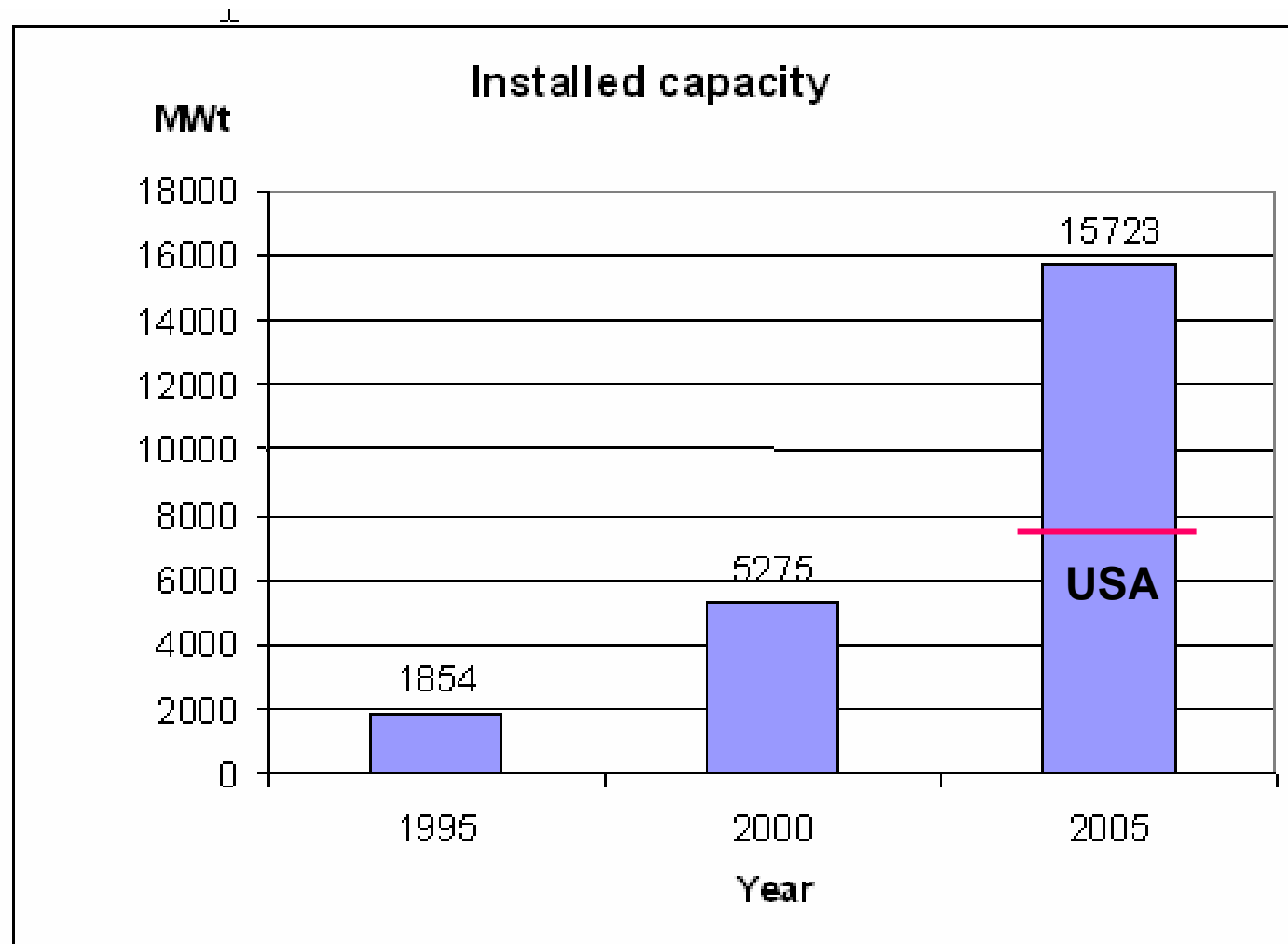
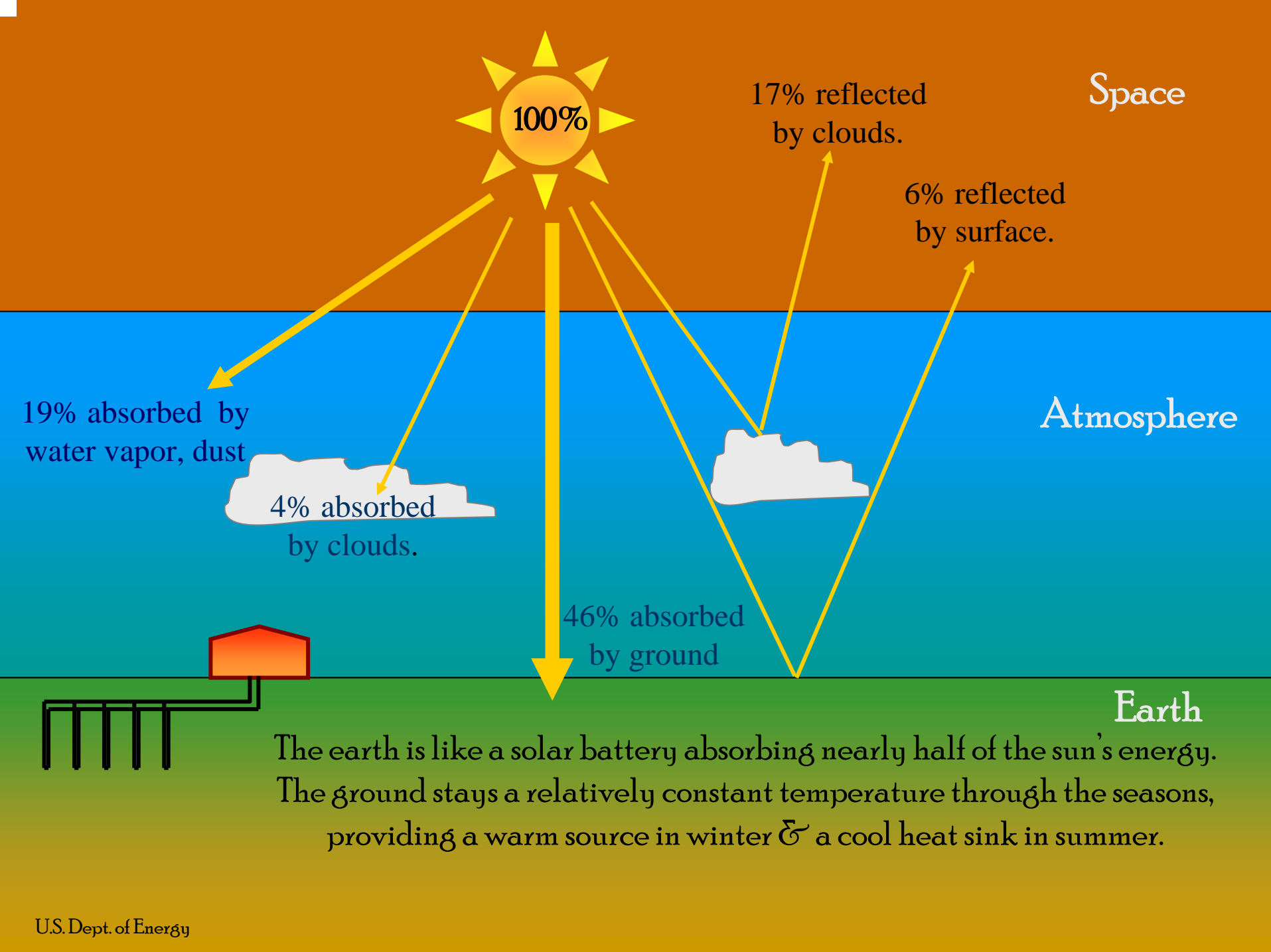
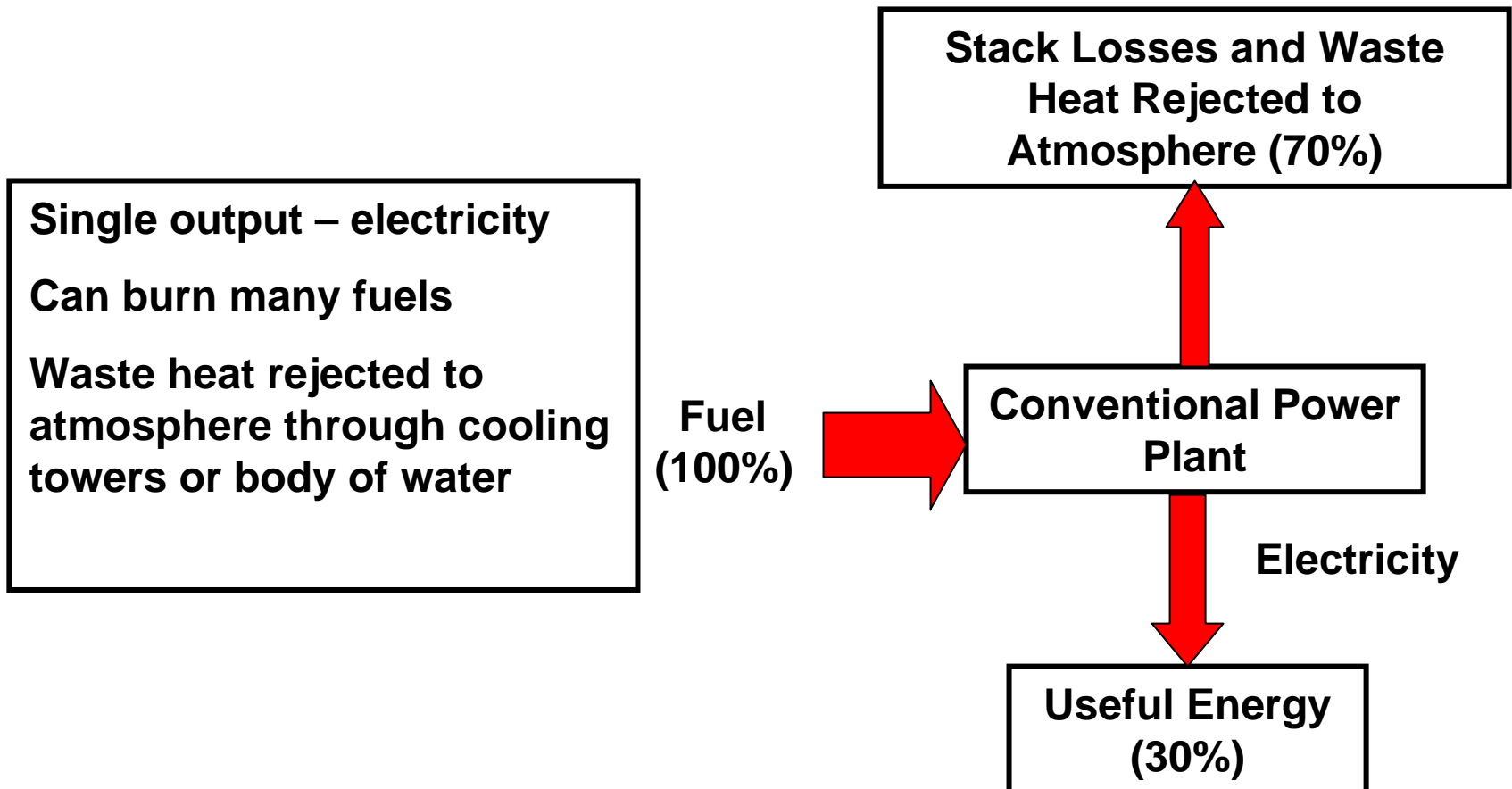


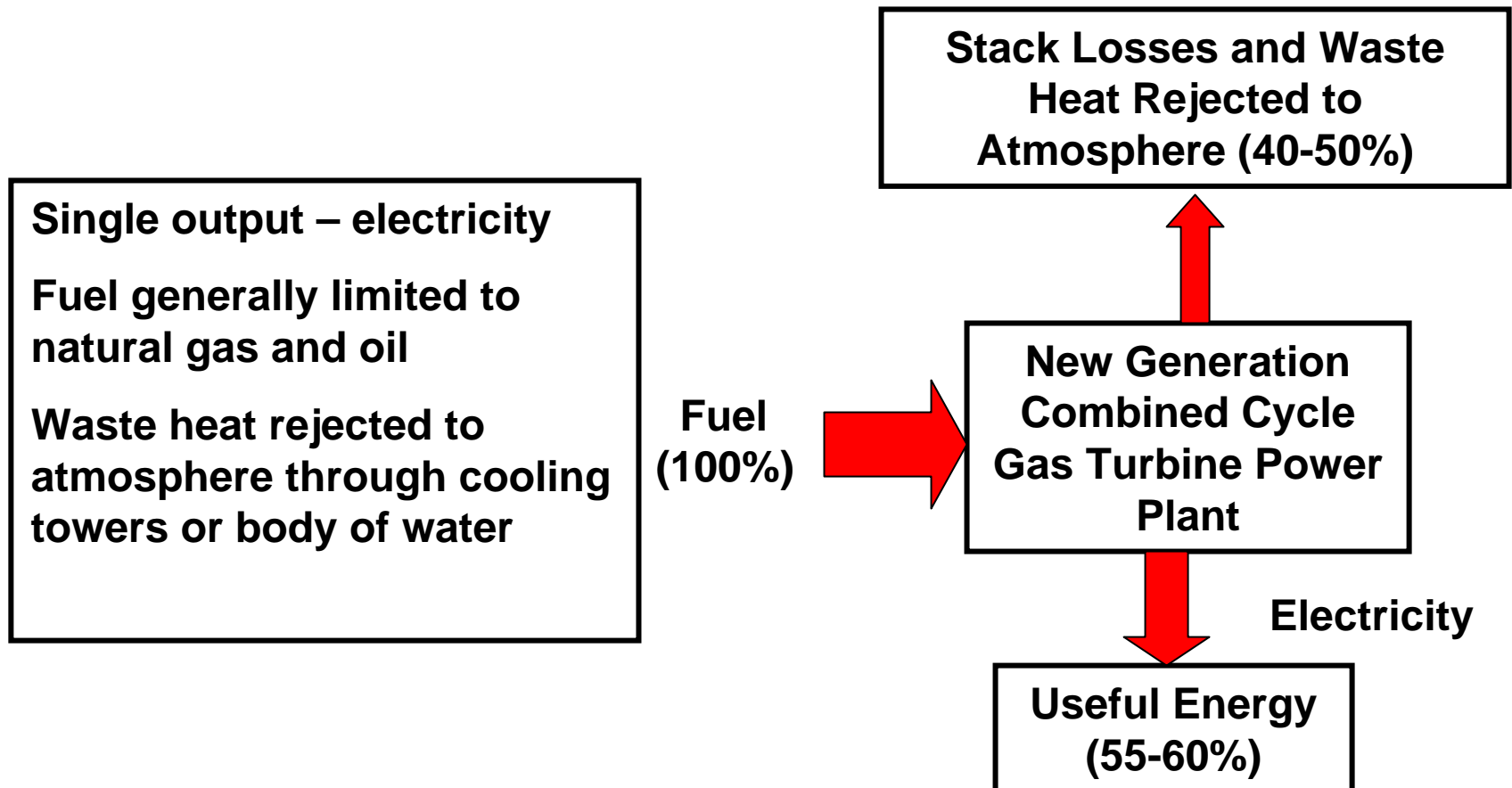
Figure 2. Growth of installed GHP capacity



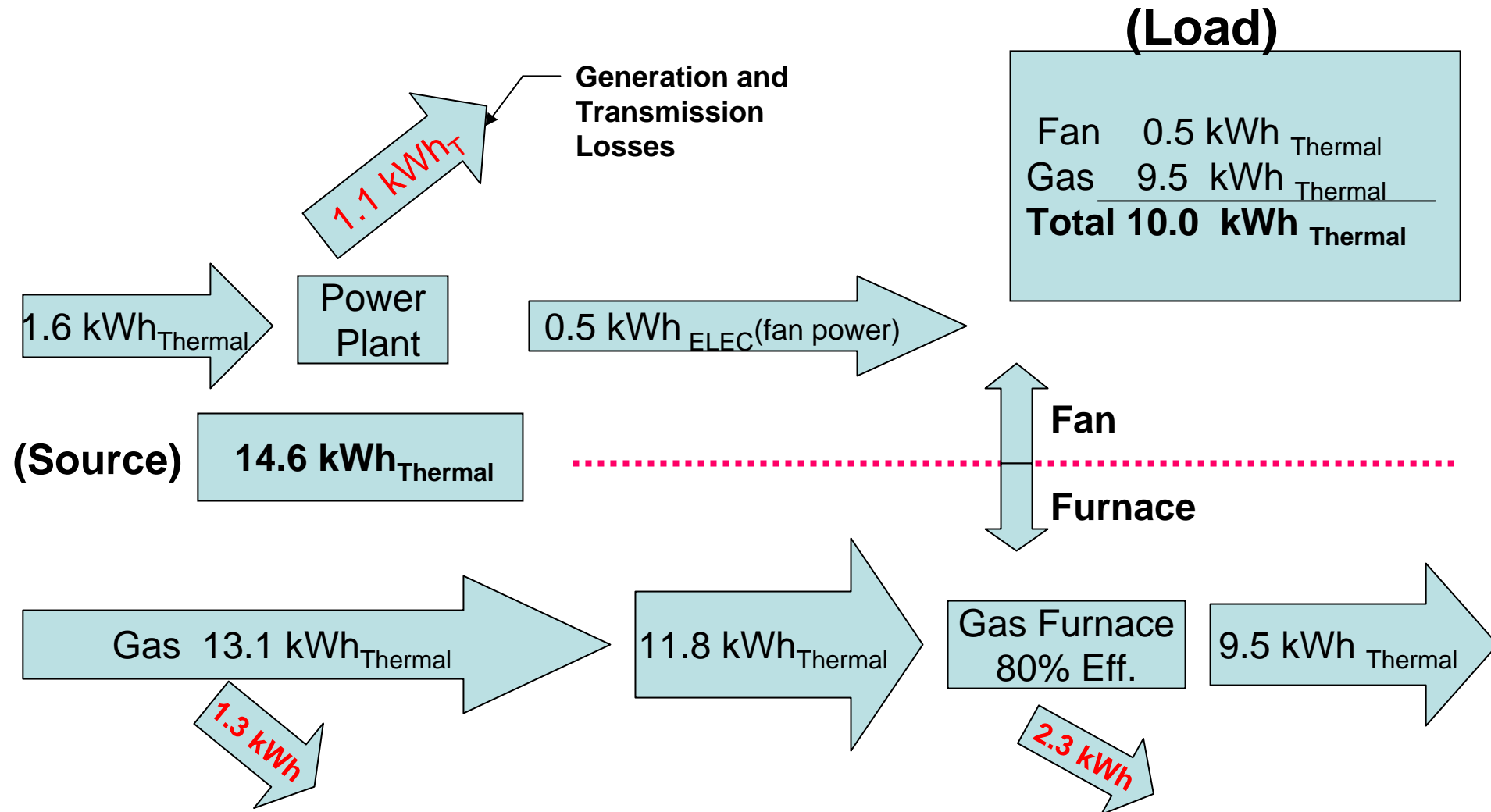
Conventional Power Plant



Combined Cycle Gas Turbine

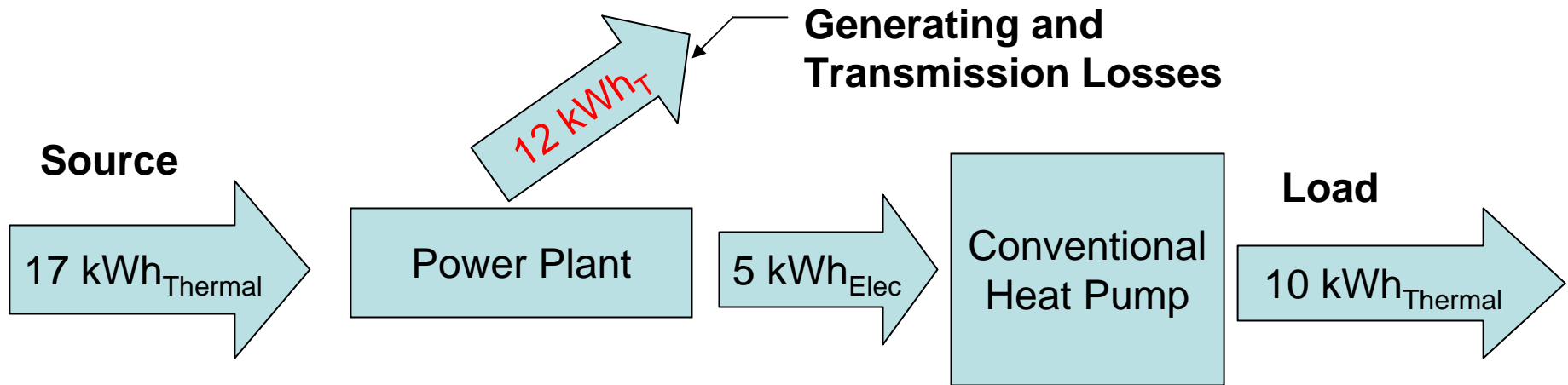


Gas/Electric HVAC System



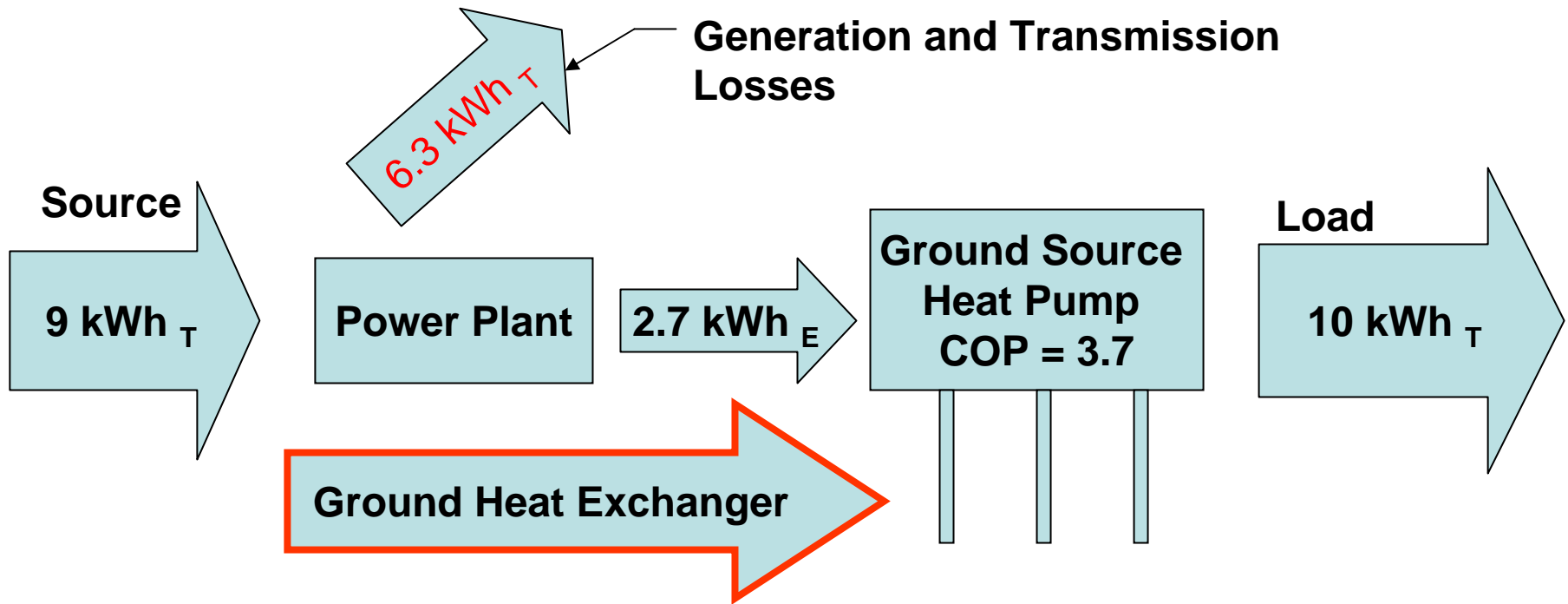
The natural gas system loses about 10% in the transmission process and another 10 to 20% at the furnace. Electricity is also needed for the furnace fans. The total required to deliver 10 kWh to the building is 14.6 from the source. This is an overall efficiency of 68% source to delivered.

Air Source Heat Pump



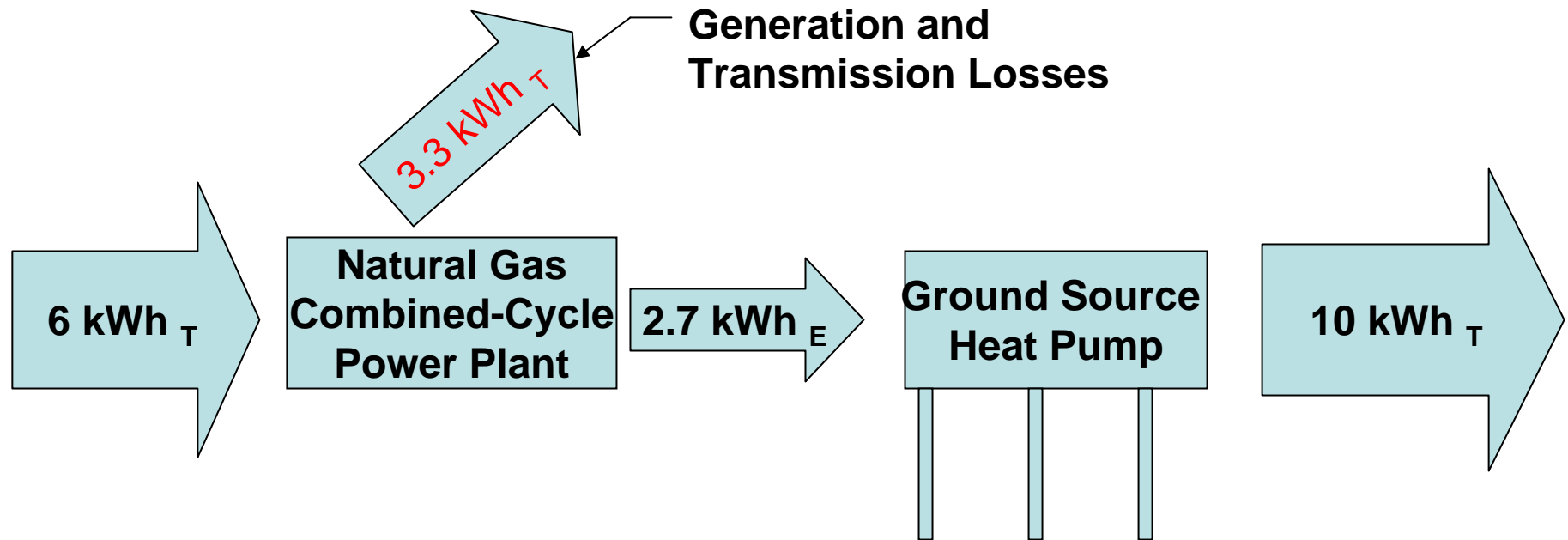
The required input energy to deliver 10 kWh of heat to a home using an air-source heat pump would be 17 kWh. About 70% of the input energy is lost during the generation and transmission process of a typical fossil-fuel power plant. The air-source heat pump will deliver a COP of 2 when defrost and auxiliary heat penalties are properly applied.

Ground Source Heat Pump



GSHP require only 9 kWh_T from the source to provide 10 kWh_T to the building since they can provide a COP of 3.7

Advanced Ground Source Heat Pump



Generation efficiency approaches 55% compared with 35% for a steam cycle alone. GSHP require only 6 kWh_T from the source to provide 10 kWh_T to the building due to the increase in power plant efficiency.

Assumptions

- **Electric Generation and Transmission Losses for Conventional Power Plant -70%**
- **Air-Source Heat Pump COP = 2**
- **Ground Source Heat Pump COP = 3.7**
- **Natural Gas Transmission Losses – 10%**
- **Gas Furnace Losses – 10 to 20%**

Reference: Steve Kavanaugh
“Outside the Loop”

Costs of Air-Cooled Equipment

- Costs due to comfort issues
- Maintenance costs
- Equipment replacement costs
- Costs due to efficiency loss of uncleaned coils

Hidden Costs of Air-Cooled Equipment

- If a program of thorough coil cleaning is not adhered to on a regular basis, a 10 Ton air cooled system with a 10 EER efficiency rating quickly becomes a 7.5 ton system with a 7.5 EER
- Yearly coil cleaning impacts the “bottom line”

Heat Exchanger Efficiency

California Energy Commission (1980's)



Low Cost Housing

- 3 Bed room
- 960 square feet
- Heating, Cooling and Water Heating averages \$17/month at \$0.07/kWh
- Conclusion – We're running out of money to save!



Total Electric GEO \$265.90/Month



Oklahoma State Capital & Bore Field



**Oklahoma State
Capital**

Bore Field



Closed Loop System

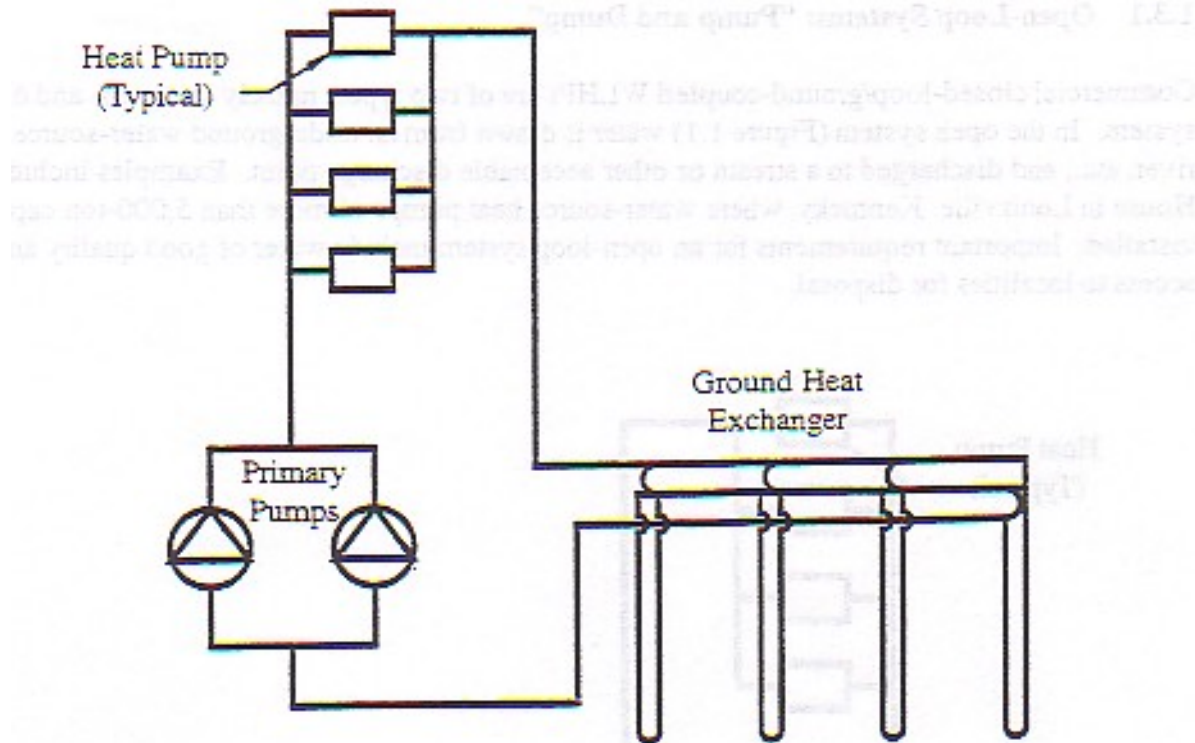
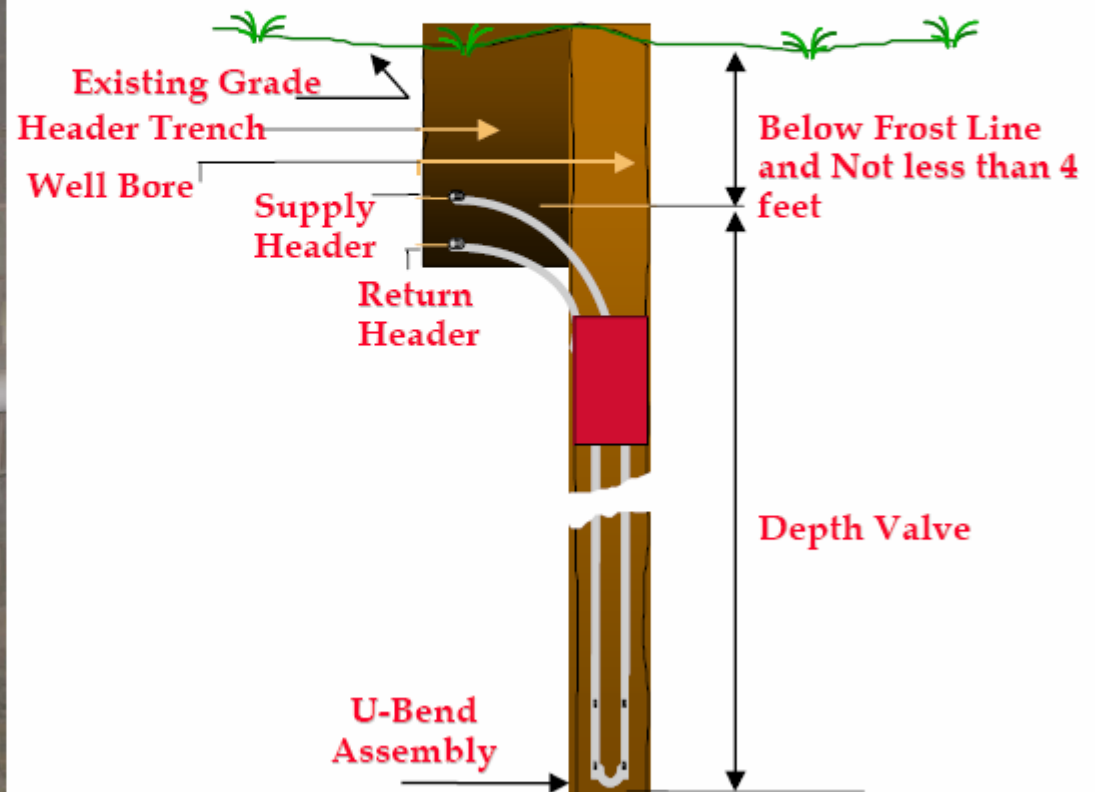


Figure 1.2 Closed Loop Ground Source Heat Pump

Typical Purge Ports and Well Bore



© DPCE 2002

Bore Holes, Trench and Header



Pre-fabricated Header Vault



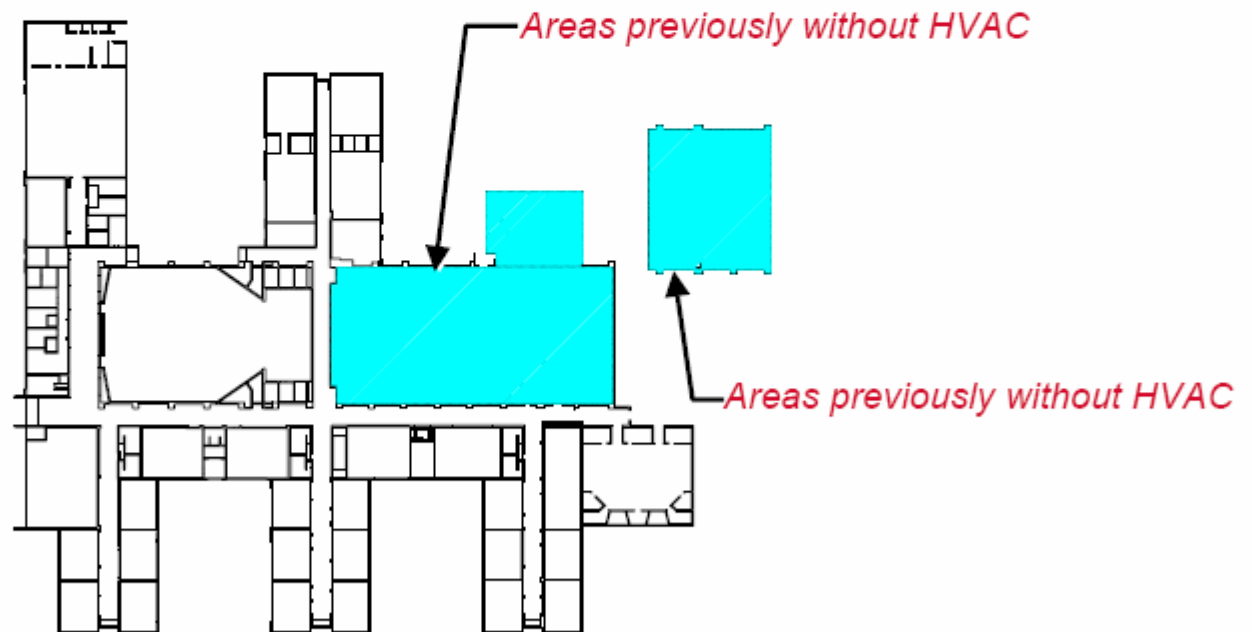
Interior of Pre-fabricated Vault



Installation of Geothermal

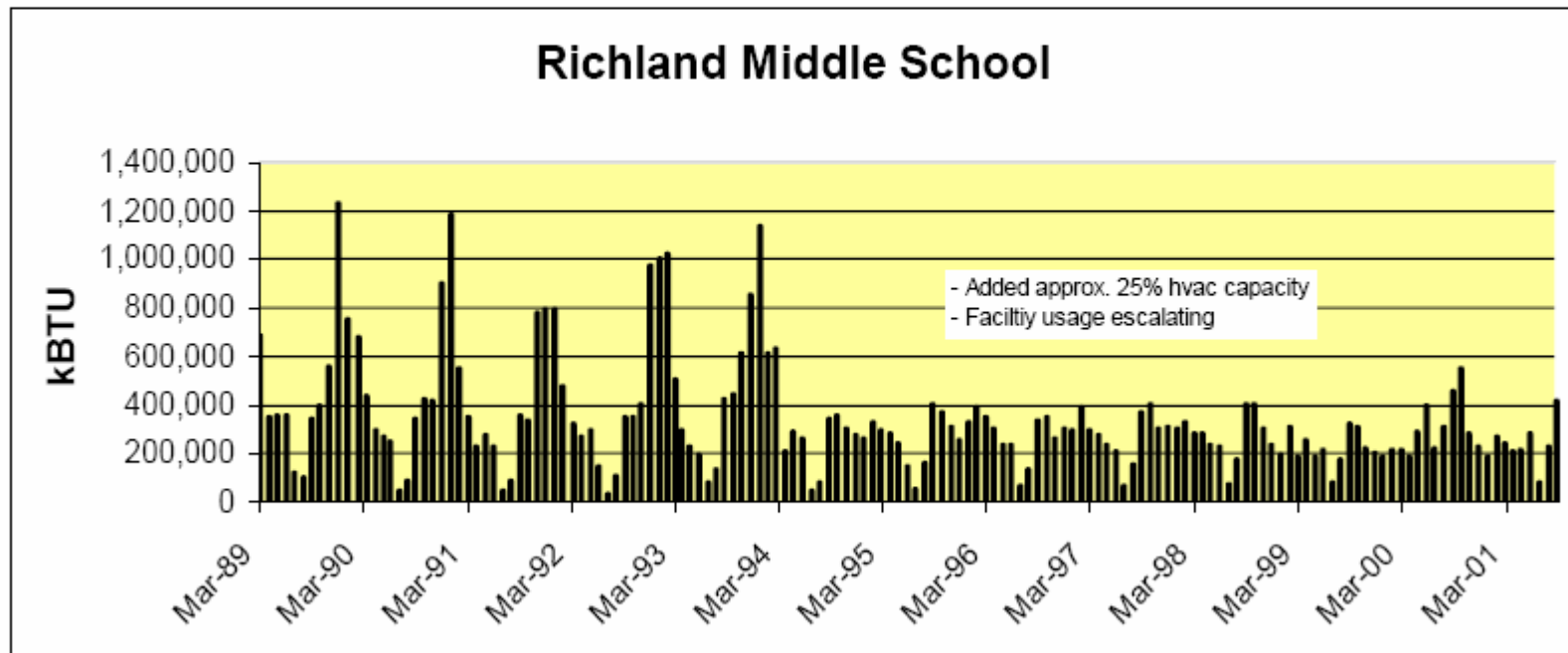
- ▲ *Use HDPE for Piping thru out*
 - ◆ *NFPA Classification of “Non-Flammable or Combustible”.*
- ▲ *Metal in Systems is limited to Pump Housings, Valve Bodies and Water to Refrigerant Heat Exchanger in GHP.*
- ▲ *Use V-Track hanger to provide neat orderly installation and eliminate pipe sagging.*
- ▲ *Individual Pump per GHP*
- ▲ *System Operates between 15 and 30 psi.*

Richland Middle School



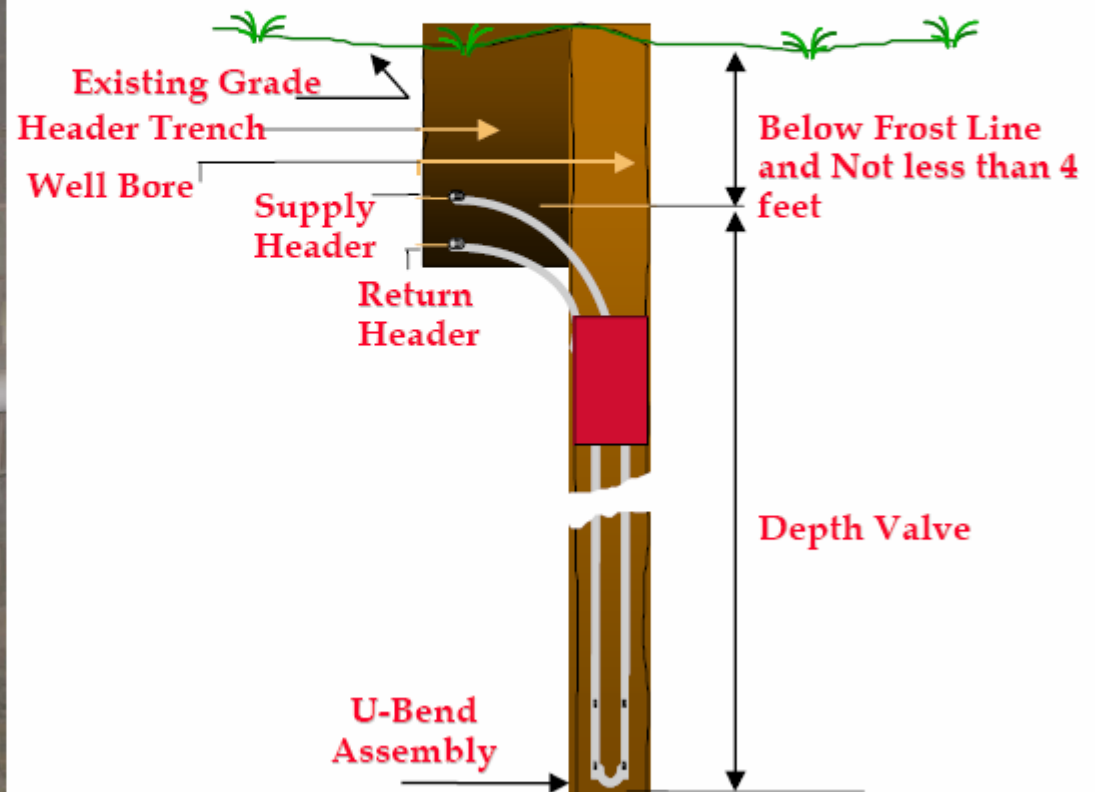
Richland Middle School - BISD

Geothermal System Installed in 1995



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Typical Purge Ports and Well Bore

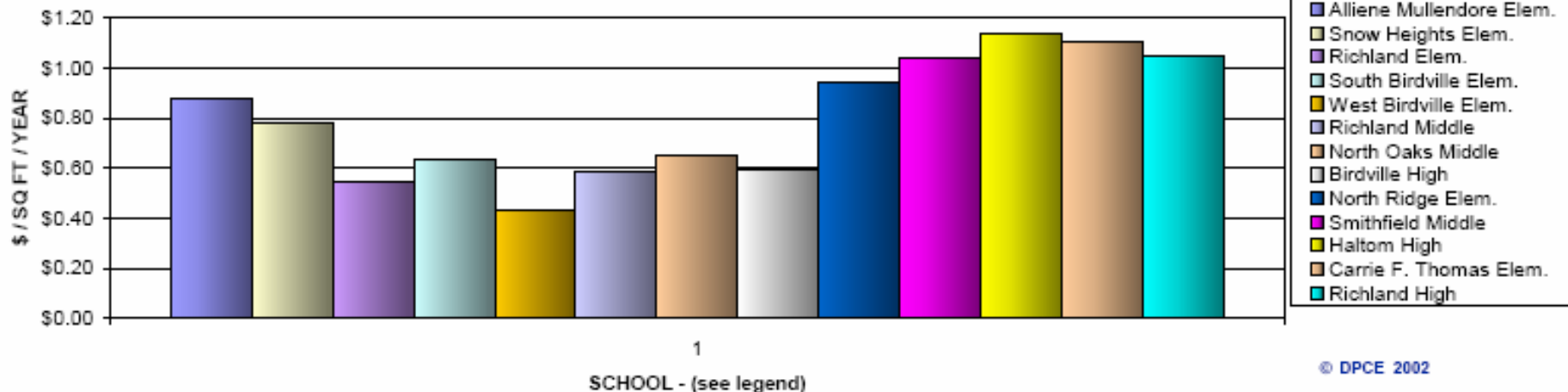


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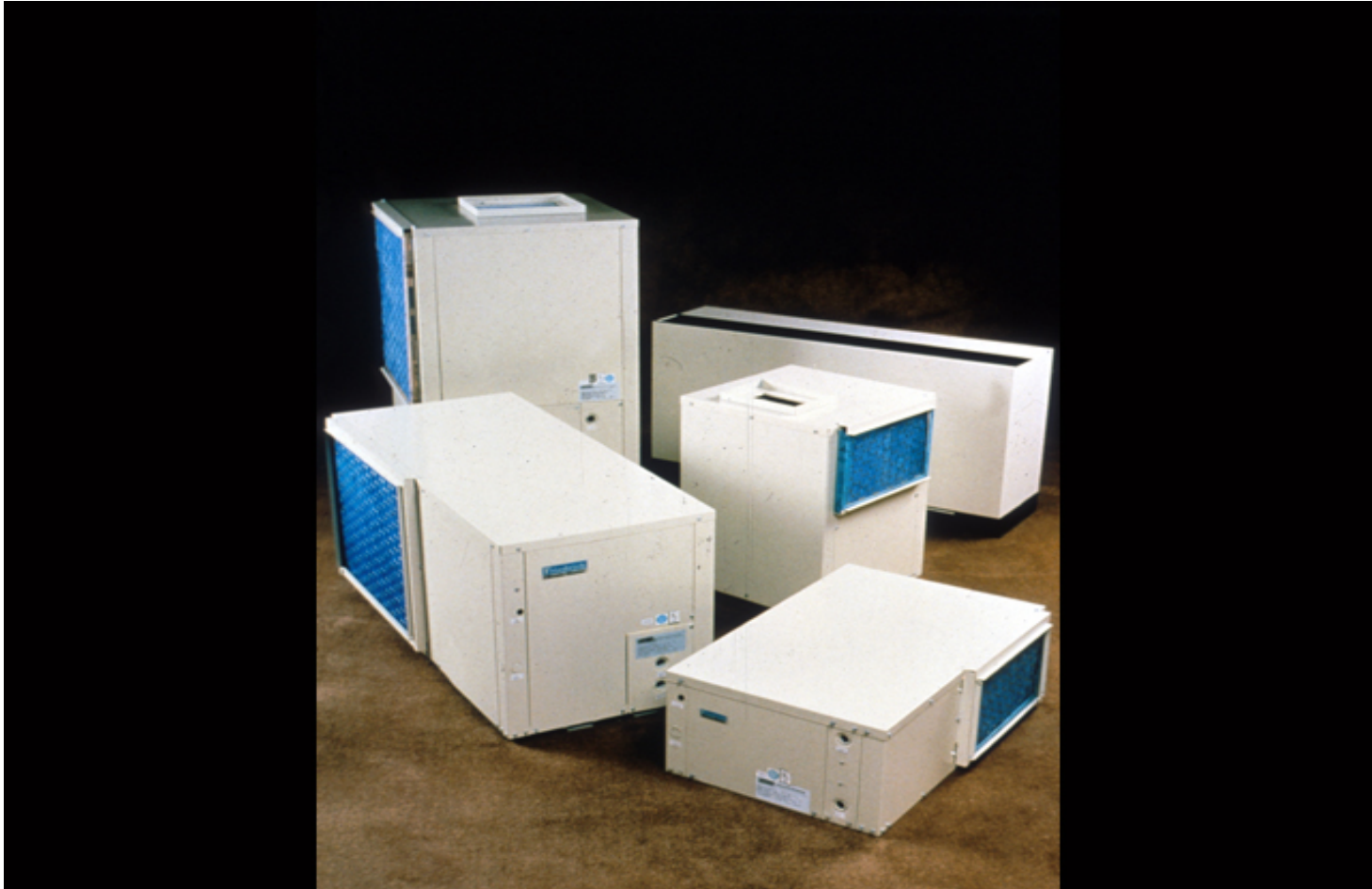
Birdville Schools Comparison – Year 2000

School Name	Cool Tons	System Type	Install Cost	Heat Type	Controls	Sq Foot	\$ / TON	Ann Elec. Cost	Ann Gas Cost	Total	\$ / SqFt
Alliene Mullendore Elem.	129	Split System	\$265,198	ELEC	Time Clock	37,632	\$2,056	\$31,323.00	\$1,828.66	\$33,151.66	\$0.88
Richland Elem.	121	Geothermal	\$266,940	ELEC	Time Clock	51,689	\$2,206	\$26,880.00	\$1,441.84	\$28,321.84	\$0.55
Snow Heights Elem.	124	RTU	\$216,720		Time Clock	34,623	\$1,748	\$24,567.00	\$2,494.00	\$27,061.00	\$0.78
South Birdville Elem.	149	Geothermal	\$243,674	ELEC	DDC	39,654	\$1,635	\$22,372.00	\$2,799.91	\$25,171.91	\$0.63
West Birdville Elem.	106	Geothermal	\$246,250	ELEC	Time Clock	67,052	\$2,323	\$27,431.00	\$1,418.90	\$28,849.90	\$0.43
Carrie F. Thomas Elem.	200	Central	\$460,000	GAS	DDC	70,600	\$2,300	\$72,872.00	\$5,177.07	\$78,049.07	\$1.11
North Ridge Elem.	200	Central	\$480,000	GAS	Time Clock	74,123	\$2,400	\$63,109.00	\$6,964.01	\$70,073.01	\$0.95
Richland Middle	273	Geothermal	\$575,038	ELEC	Time Clock	96,022	\$2,110	\$46,323.00	\$10,026.49	\$56,349.49	\$0.59
North Oaks Middle	204	Geothermal	\$444,760	ELEC	Time Clock	79,856	\$2,186	\$46,323.00	\$5,495.11	\$51,818.11	\$0.65
Smithfield Middle	320	Gas Chiller	\$644,371	GAS	DDC	94,908	\$2,014	\$78,300.00	\$20,189.75	\$98,489.75	\$1.04
Haltom High	1,100	Central	\$2,530,000	GAS	DDC	305,000	\$2,300	\$315,870.00	\$30,153.62	\$346,023.62	\$1.13
Richland High	913	Central & Split System	\$1,830,000	ELEC/GAS	DDC	274,045	\$2,004	\$252,383.29	\$34,839.04	\$287,222.33	\$1.05
Birdville High	1,046	Geothermal	\$2,415,000	ELEC	DDC	301,000	\$2,309	\$173,819.00	\$5,394.30	\$179,213.30	\$0.60

ELECTRICAL/GAS COMPARISON



Water Source Heat Pumps



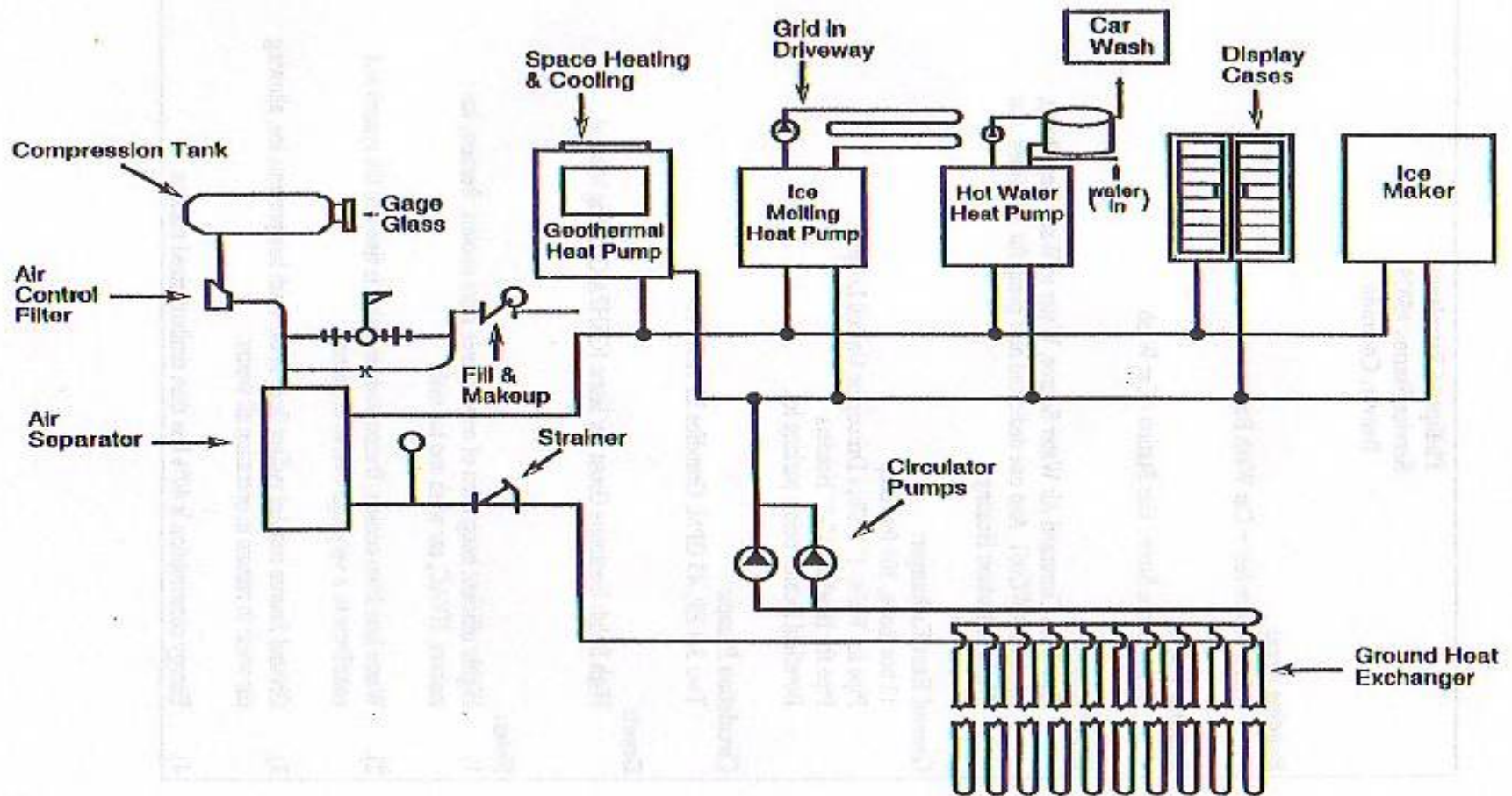
Retirement Center Distributed Closed-Loop



Greenhouses



Integrated System



Service Centers Integrated System



Open/Closed Loop Pond Systems



Retrofit Apartment Complexes



Townhouses



Slinky Installation



Two Office Buildings and Eight Residences with Hybrid Ground HEX System



Chinese Trade Center- Hengdian



11.22.2001

Apartment Complex-Shanghai



8th Army Korea



Olympic Village Beijing



The Texas House

- Energy Conserving
- 4 Heat Pumps for Zone Control
- Vertical Heat Exchanger Field
- Very Proud Owner



George's Units

- Howard's Design
- OSU Graduate of MET Department
- Personal Relationship (Howard and #1)
- Recommended by #1 to Friends and Acquaintances



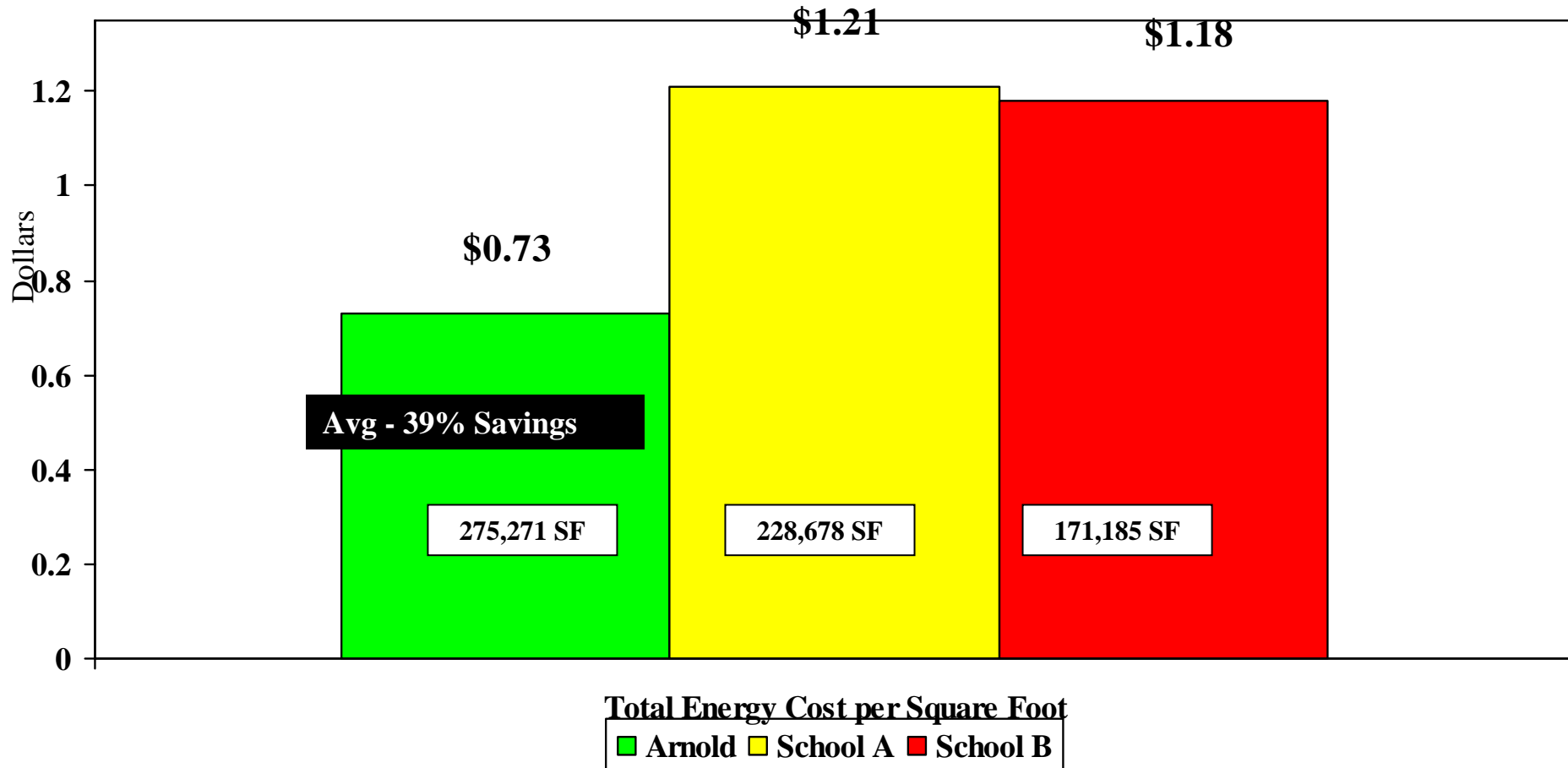
ARNOLD HIGH SCHOOL



ARNOLD HIGH SCHOOL



Geothermal School Annual Energy Operating Costs Comparison

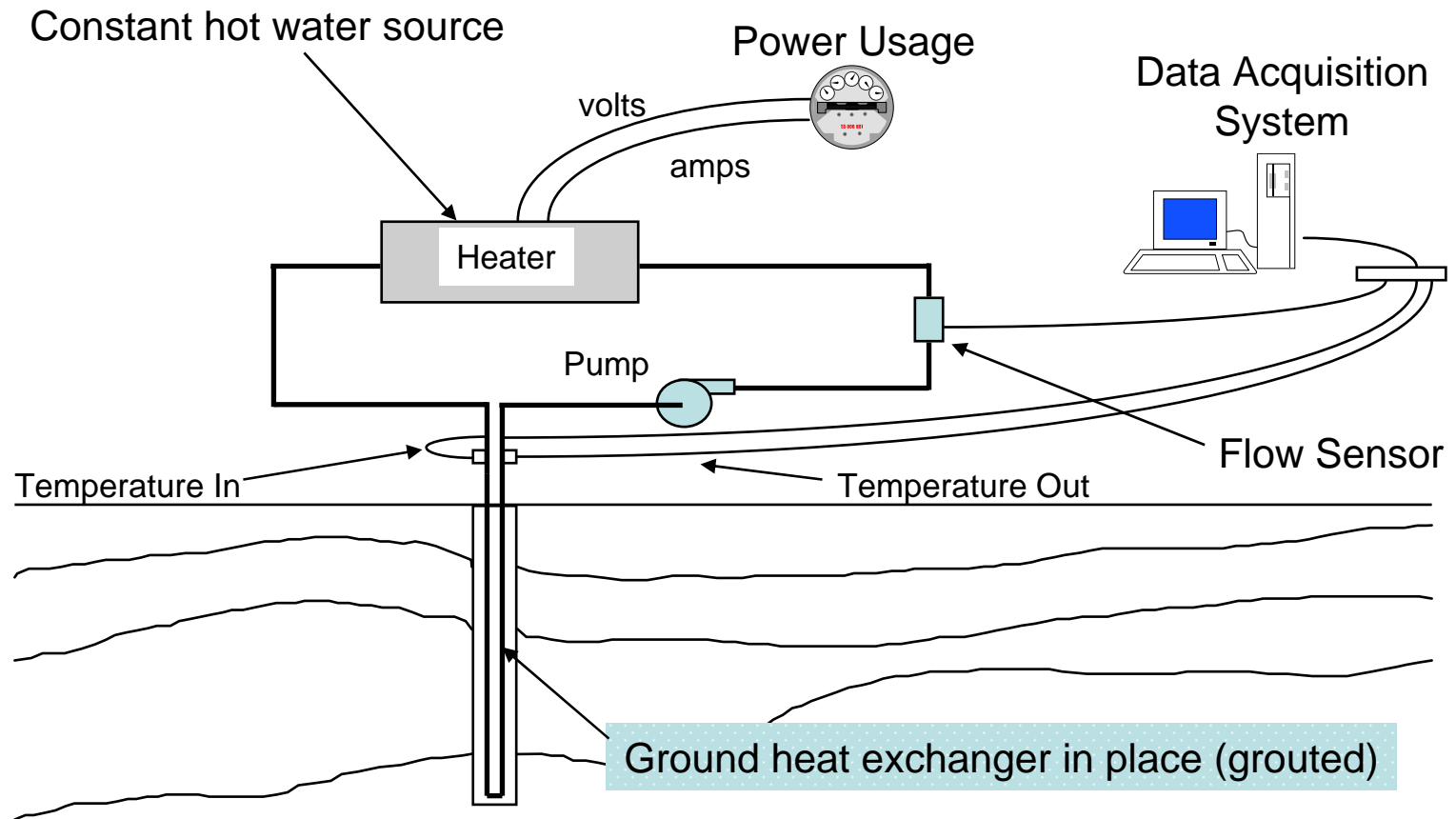


* Arnold High - **Closed-Loop Geothermal System** (completed Aug, 2000)
* School A - Gas Boiler/Chiller System (Updated w/ new equipment 1996)
* School B - Multiple Systems

System Design

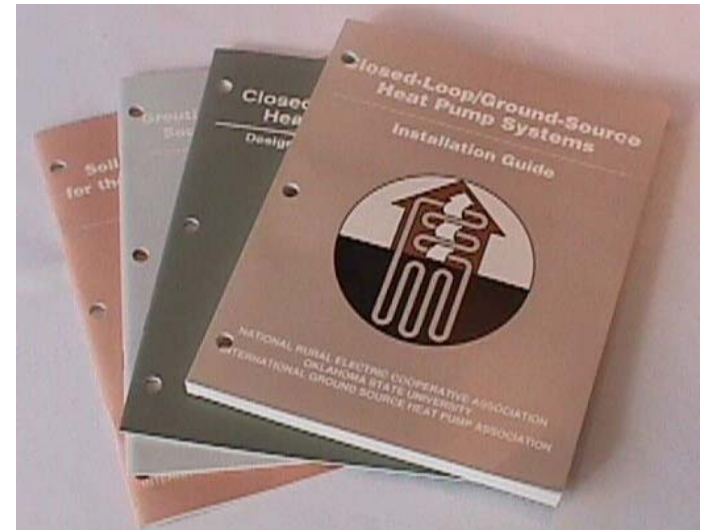
- Open Loop
 - Pump and dump
 - Standing column
 - Ponds/lakes (direct and indirect)
- Closed Loop
 - Vertical
 - Horizontal
 - Hybrid
- Soil/Rock Thermal Testing
- Grouting

In-situ Test System Schematic



Existing Resources for Designers

- Design Manuals
- Computer Software
 - Residential
 - Commercial
- Manufacturers Training
- Conferences



Certified GeoExchange Designer Training

As an architect or engineer,

you have specific questions about GSHP systems that you want answered. IGSHPA has designed a program to offer advanced training towards certification as a GeoExchange Designer (CGD). From an introduction to the technology to a complete review of the design process, participants learn the specific information they need to know. IGSHPA has entered into a cooperative endeavor with the Association of Energy Engineers (AEE) and the Geothermal Heat Pump Consortium (GHPC) to provide training for the Certified GeoExchange Designer Program. Participants will receive a copy of the *Closed-Loop/ Ground-Source Heat Pump Systems Installation Guide*, as well as other manuals in the CGD Notebook.

Who should attend?

The Certified GeoExchange Designer course is designed for professional engineers, registered architects, installers, and contractors. This course is essential for individuals wanting advanced training and experience in designing GSHPs, and required for experienced individuals who wish to earn certification.

Topics

- Ground Source Heat Pump Design
- Loop Systems, Open Systems
- Soil/Rock Classification and Conductivity
- Grouting Procedures
- Commercial Ground Loop Heat Exchanger Software
- Performance of Ground Source Heat Pumps in Housing Units

Registration information

After you register, a confirmation letter, hotel listings, an agenda, and a necessary course supplies list will be sent to you. If you pay when you register, you will also be sent a reading list and your manuals.

Cancellation policy

The full tuition fee may not be refunded unless you notify IGSHPA a minimum number of days in advance. Please refer to the registration form for specifics.

Certification Process

Certification is accomplished by application to AEE. To become certified the candidate must:

1. Determine if eligible under the Eligibility Requirements listed.
2. Register for and attend the IGSHPA CGD Workshop.
3. Pass the IGSHPA CGD exam.
4. Complete a separate application with additional fee to AEE, initiating the certification process.
5. Certification will be awarded by AEE after their evaluation of the candidate's qualifications.

Attending the CGD Workshop and passing the CGD exam are only a part of the certification process and will not automatically lead to certification. Contact AEE at 1-770-447-5083, ext. 223 for an application and fee information.



Eligibility requirements

Each candidate for certification must meet one of the following four sets of criteria:

- Be an engineering graduate and/or Professional Engineer or Registered Architect with three years of verified, combined experience in geothermal heat pump design, heating, ventilation and air-conditioning.
- Have a four-year, non-technical degree with five years of verified, combined experience in geothermal heat pump design, heating, ventilation and air-conditioning.
- Have a two-year technical degree with eight years of verified, combined experience in geothermal heat pump design, heating, ventilation and air-conditioning.
- Have ten years or more verified, combined experience in geothermal heat pump design, heating, ventilation, and air-conditioning.

Accredited Installer Training

Learning to install

GSHP systems will keep you competitive in a market forced to deal with rising energy costs and resource depletion. Installer accreditation enables you to open new markets and offer customers a low-maintenance, economical, and environmentally friendly alternative for their space conditioning needs.

With over fifteen years of experience teaching these workshops, accrediting thousands of installers, and setting the industry standard, IGSHPA has maintained close ties with Oklahoma State University, and pioneered training in GSHP installation.

Who should attend?

The three day comprehensive Installation Workshops are designed for GSHP developers, architects, manufacturers, distributors, dealers, installers, HVAC contractors, trenching/drilling contractors, and anyone who desires a working knowledge of this innovative technology.

Representatives from public utilities, private utilities, and rural electric cooperatives can also benefit from training. Information gathered from the workshops can help utility representatives serve as a source of information regarding money-saving concepts.

Accreditation

Upon successful completion of the workshop and passing the IGSHPA installer's exam, you will be issued IGSHPA accreditation as an installer of GSHP systems. You will receive an installer's card and a certificate.

In most instances, you will receive a membership with IGSHPA after you have completed the Installation Workshop. Membership in IGSHPA is required to be an Accredited Installer and maintain accreditation.

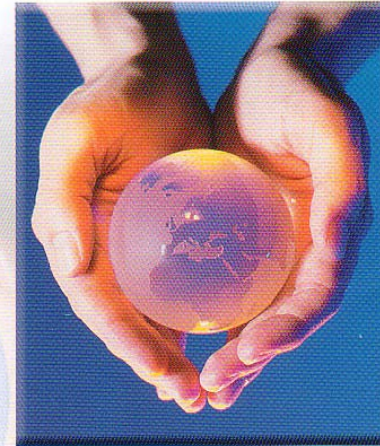
Topics

- Design and Material Options
- System Layout
- Pipe Joining Techniques
- Trenching/Drilling Processes
- Air and Debris Purging
- Pressure Drop Calculations
- Pump and Fluid Selection
- Thermal Conductivity

Group discounts and on-location training

A group discount is available if five or more people attend from your company or organization.

For an additional fee, IGSHPA offers its Installation Workshops on location. Call 800-626-4747 for more information.



Registration information

After you register, a confirmation letter, hotel listings, and an agenda will be sent to you. Before securing travel arrangements, please check the agenda for class times. If you pay when you register, you will also be sent a reading list and your manuals.

Cancellation policy

The full tuition fee may not be refunded unless you notify IGSHPA a minimum number of days in advance. Please refer to the registration form for specifics. You may designate another individual as your substitute at any time.

